



ASSESSMENT OF LOBSTER STOCKS OF THE MAGDALEN ISLANDS (LFA 22), QUEBEC IN 2011

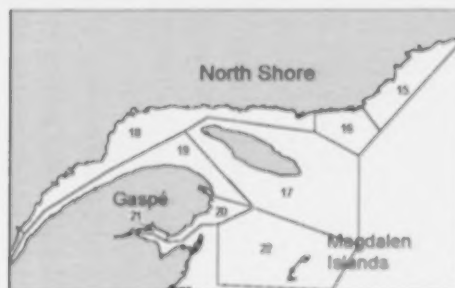


Figure 1: Map showing the lobster fishing areas (LFAs) in Quebec (LFAs 15 to 18: North Shore and Anticosti, LFAs 19 to 21: Gaspé Peninsula and LFA 22: Magdalen Islands).

Context

Lobster fishing in the Magdalen Islands (LFA 22, Figure 1) is practiced by 325 enterprises (a skipper-owner and one or more fishers' helpers). About two-thirds of the fleet is on the south side (Old Harry to Havre-Aubert) and one-third is on the north side (Grosse-Île to Millerand) (Figure 2). The fishery is managed by controlling the fishing effort (number of licences, number and size of traps, fishing season and daily fishing schedule, organization of trap lines) and by escapement measures (release of berried females and minimum legal size). The management and conservation measures introduced over the past 15 years follow the recommendations of the Fisheries Resource Conservation Council (FRCC). In 2011, a precautionary approach was suggested for LFA 22. It will guide future management decisions. The resource status is assessed every three years. This report describes the situation in 2011 and the changes observed since the last stock status assessment in 2008.

SUMMARY

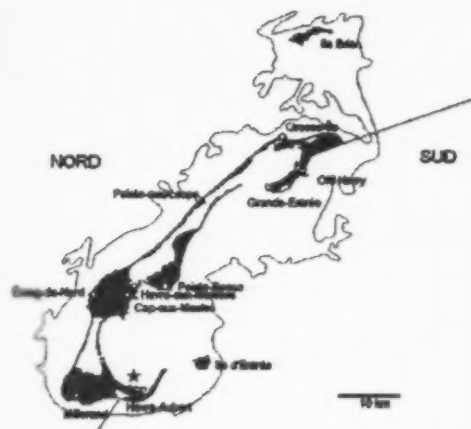
- The **abundance indicators** were quite high in 2011. A total of 2 648 t were landed, which is higher than in 2008 and 18% above the average of the past 25 years (2 251 t). Landings reached a historic high of 3 033 t in 2010. Catches per unit effort (CPUEs) in number and weight of commercial lobsters and the commercial density and biomass from the trawl survey were also higher than they were in 2008 and above the series average.
- With regard to the **demographic indicators**, the average size of commercial lobsters has remained rather stable since 2008 and since the minimum legal size was increased in 2003. The sex ratio is still stable and balanced. The size structures are still truncated, but the proportion of jumbo lobsters (≥ 127 mm in carapace length, CL) has increased slightly since 2008.

- The **fishing pressure indicators** show that exploitation rates are still high. However, since 2003, fishing mortality for the portion of the population ≥ 76 mm CL dropped as a result of the increase in the minimum legal size.
- The **productivity indicators** remained high. With regard to **reproduction**, the abundance of berried females and egg production were higher in 2011 than in 2008. The contribution of multiparous females to this production also increased. **Recruitment** indices suggest that landings in 2012 and 2013 will remain high. Juvenile abundance indices show excellent potential for maintaining good recruitment to the fishery in the longer term (8–10 years).
- It can be concluded that with its high abundance and productivity, the lobster stock in the Magdalen Islands is in good shape and that under the present environmental conditions, current exploitation levels do not compromise its sustainability. However, a decrease in exploitation rates could theoretically improve the size structure.
- A **precautionary approach** was suggested for LFA 22 and reference points were determined in order to define the three stock status zones (healthy, cautious and critical). Lobster stocks in the Islands are currently in the **healthy zone**.

INTRODUCTION

Biology

American lobster (*Homarus americanus*) occurs along the west coast of the Atlantic Ocean, from Labrador to Cape Hatteras. Adult lobsters prefer rocky substrates where they can find shelter, but can also live on sandy and even muddy bottoms. Commercial concentrations are generally found at depths of less than 35 m. In the Magdalen Islands, females reach sexual maturity at around 79 mm carapace length, CL on the south side and around 84 mm CL on the north side. Males reach sexual maturity at a smaller size. Females generally have a two-year reproductive cycle, spawning one year and moulting the next. Females spawning for the first time can produce nearly 8 000 eggs while large females measuring 127 mm CL (jumbo size) can lay up to 35 000 eggs. In addition to being more fertile, certain large females could spawn for two consecutive years before moulting. Once released, the eggs remain attached to the females' swimmerets for 9 to 12 months, until the planktonic larvae hatch the following summer. Spawning and hatching can occur earlier in the season for multiparous females (females spawning for the second time at least) than for primiparous females. It was also noticed that larvae at the time of release could be larger for multiparous females than for primiparous females. The larvae's planktonic phase lasts from 3 to 10 weeks, depending on the temperature of the water. Following metamorphosis, postlarval lobsters (stage IV), which now resemble adult lobsters, drift down from the surface layer to settle on the sea floor. The survival of lobster from their larval stage to their initial benthic stages is impacted by predation as well as by hydrodynamic factors that cause advection or retain the larvae near the areas that are favourable for benthic settlement. During the first few years of benthic life, until they reach approximately 40 mm, lobsters lead a cryptic existence; i.e. they live hidden in habitat providing many shelters. Lobsters are estimated to reach the MLS (83 mm) at around eight or nine years of age after having moulted approximately 16 times since their benthic settlement.



Description of the fishery

Fishery management also includes escapement measures. In addition to having an MLS (carapace length), berried females must be released. Starting in 1997, the MLS was increased by one millimetre every year for seven years. It reached 83 mm in 2003 but was 76 mm from 1957 to 1996. Increasing the MLS enabled the objective of doubling 1996 egg production levels per recruit to be met.

STOCK STATUS ASSESSMENT

Source of data

The stock status assessment is based on indicators of abundance, demographics, fishing pressure and stock productivity. Abundance indicators include landings recorded on processing plant purchase slips and catch rates of commercial-size lobsters obtained from samplings. The demographic indicators are taken from the lobster size structures and include mean size and weight, jumbo (≥ 127 mm) abundance, and sex ratios. The fishing pressure index (exploitation rate) is derived from a measurement of the ratio between the number of individuals (males) from the first moult class recruited to the fishery in a given year and that of the second moult class recruited to the fishery one year later (tracking cohort strength). Productivity indicators are based on abundance of berried females and on egg production (reproduction), abundance of

pre-recruits (one year before the fishery), and cohort strength at the time of benthic settlement (recruitment). The indicators are compiled mainly from two sources of data: at-sea sampling, which has been conducted on board fishing vessels since 1985 and covers sea floors on the south and north sides of the Islands; and a trawl survey, which has been conducted on the south side of the Islands since 1995. The latter is a source of fishery-independent data. In addition, divers have studied the benthic settlement of lobster in the Les Demoiselles area (Baie de Plaisance) since 1995. For each indicator, data from the three previous years are examined and the 2011 data are compared to the averages from the existing data series before that year.

Abundance indicators

Landings

Landings for the Magdalen Islands reached 2 648 t in 2011 (preliminary data) (Figure 3). They increased by 6.5% compared to 2008 (2 487 t). In 2011, they were more than 17.6% of the average of the past 25 years (1986–2010) (2 252 t). In 2010, they reached a historic high of 3 033 t, breaking the record observed in 1992. In 2011, they were higher than in 2008 on the south and north sides. The south side accounted for 69% of the total landings on the Islands (1 804 t); the north side accounted for the other 31% (818 t). In 2011, lobster landings from the Magdalen Islands accounted for 71.3% of the total landings in Quebec (3 716 t).

Catch rates for commercial-size lobsters (≥ 83 mm CL)

Catch rates correspond to the catches per unit of effort (CPUEs) expressed in number or weight of lobster per trap. In 2011, for all of the Islands, the CPUE for commercial-size lobsters was 0.84 per trap, which corresponds to a weight of 0.56 kg/trap (Figures 4A and 4B). The CPUE in number in 2011 was 6.3% higher than that in 2008 and 10.5% above the series average (1985 to 2010) (0.73 lobster/trap [l/t]). The CPUE in weight was 27% higher than that in 2008 and 33% above the series average (0.42 kg/trap).

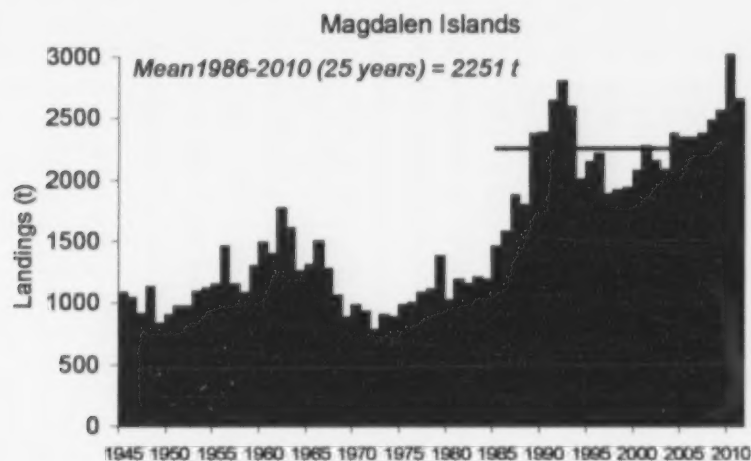


Figure 3. Lobster landings in the Magdalen Islands from 1945 to 2011.

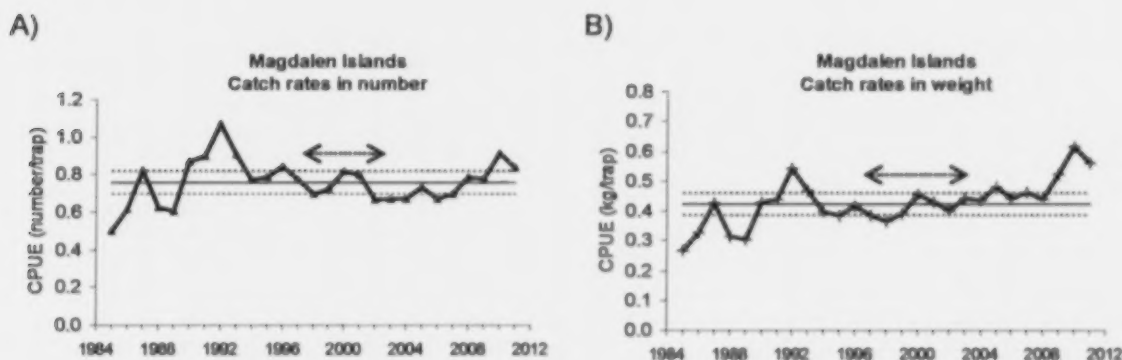


Figure 4. Catch rates (CPUE) of commercial-size lobsters for the Magdalen Islands from 1985 to 2011 in A) number and B) in weight per trap. 1985–2010 mean (solid line) ± 0.5 standard deviation (dotted lines). The horizontal arrow indicates the period (1997 to 2003) when the MLS was increased by 1 mm per year, from 76 to 83 mm.

Number and biomass of commercial lobster (trawl)

The lobster population sampled in the fall of one year during the trawl survey represents the population to be available to the fishery in the spring of the following year. The commercial lobster density observed in the 2010 trawl survey was 7.8 lobster/1 000 m² (Figure 5A). The corresponding biomass was 6.1 kg/1 000 m² (Figure 5B). The values observed in 2010 were respectively 33.7% and 25.3% higher than those observed during the 2007 trawl survey. The 2010 values were above the 1995–2009 series average.

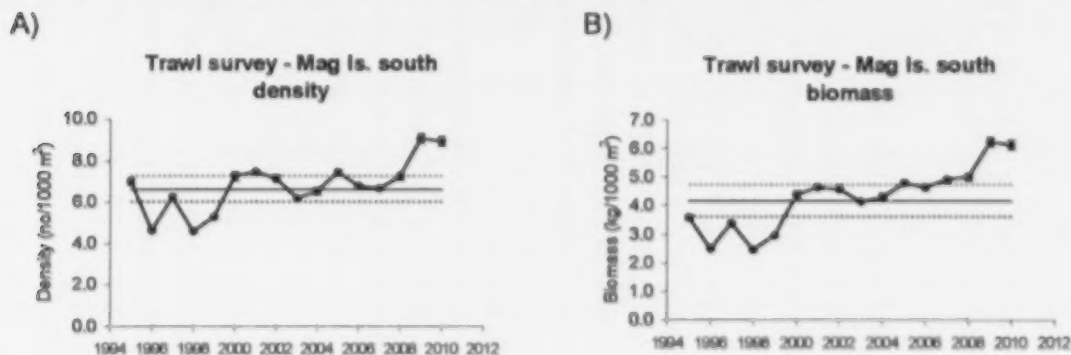


Figure 5. Commercial-size lobster A) density and B) biomass (kg) per 1 000 m² (mean \pm 95% c.i.) observed during the September trawl survey conducted on the south side of the Magdalen Islands between 1995 and 2010. 1995–2009 mean (solid line) ± 0.5 standard deviation (dotted lines).

All of the abundance indicators have increased since 2008. Landings and CPUEs in weight from commercial sampling are significantly correlated ($p < 0.01$) to the biomass from the previous year's trawl survey for the period of 1995 to 2010 ($r = 0.85$ and 0.82 , respectively).

Demographic indicators and fishing pressure

There was no notable change in commercial-size lobster size structures (≥ 83 mm) since 2008 (Figures 6A and 6B) or since the MLS was increased in 2003. The size structures have a truncated appearance and are dominated by a moult class of 83–94 mm for males and 83–90 mm for females corresponding to the year's recruits. Female size distributions are more truncated toward small sizes than male size distributions are. This reflects a decrease in female growth as they reach sexual maturity.

The mean size and weight of landed lobsters has remained stable since 2008 (around 91 mm CL and 640 g in the south and around 92 mm and 660 g in the north). The stability in the mean size and weight of commercial-size lobsters was also observed in the trawl survey. The proportion of jumbo lobsters (≥ 127 mm) observed during at-sea sampling is generally less than 1%. It was 0.4% in 2011 on the south side of the Islands compared to 0.7% in 2008. In the trawl survey conducted in the fall of 2010, the proportion of jumbos was 1.1% compared to 0.6% in the fall of 2007. The proportion on the north side reached 0.7% in 2011 compared to 0.3% in 2008.

Truncated size structures are indicative of high exploitation rates. Exploitation rates calculated for commercial-size males were 75% in the south and 68% in the north in 2010. There was not much variation in these values since 2003 but they are above the 1985–2009 series average (68% in the south and 60% in the north). The exploitation rate calculated from the trawl survey data has also shown some stability since 2003 ($66.3 \pm 1.7\%$) (mean \pm standard error). The exploitation rate index for males ≥ 76 mm has decreased by about 50% since the MLS of 83 mm was reached.

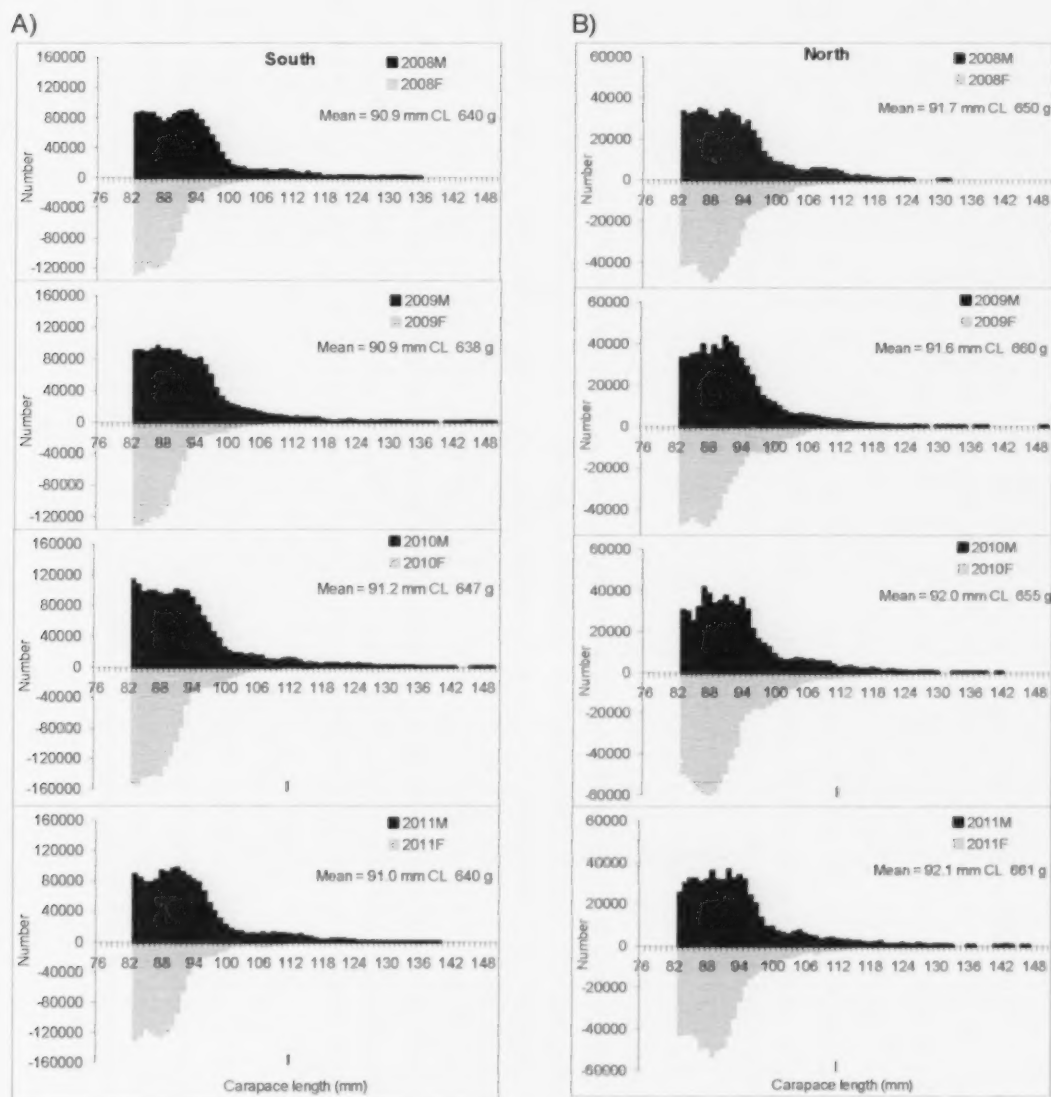


Figure 6. Size frequency distribution of male lobsters (black) and female lobsters (grey) (commercial portion) from 2008 to 2011 for A) the south side and B) the north side of the Magdalen Islands. The frequencies are weighted by landings.

Productivity indicators

Berried females and egg production

In 2011, for all of the Islands, the CPUE of female lobsters was 0.23 l/t. The average CPUE since the MLS was increased to 83 mm (2003 to 2010) was 0.18 l/t compared to 0.09 l/t for 1985 to 1996 when the MLS was 76 mm CL (Figure 7). The 2011 CPUE was higher than in 2008 (0.13 l/t). An abundance index for mature females (≥ 79 mm) calculated from data in the trawl survey also shows an increase from 1995 to 2010. The density of mature females was less than 3 lobsters/1 000 m² before 1997 and reached 5 lobsters/1 000 m² in the fall of 2010.

The examination of the size structure of berried females shows a strong mode under the MLS on the south and north sides (Figures 8A and 8B). On the south side, 62% of berried females are under the MLS whereas on the north side, 30% are below it. Before the MLS was increased, most of these females did not contribute to egg production. In 2011, the average size of berried females was 81.5 mm in the south and 87.1 mm in the north. The largest size of berried females on the north side is mainly explained by a larger size at sexual maturity. Berried female size structures from the trawl survey are similar to those from at-sea sampling on the south side of the Islands. In 2011, multiparous females (those that spawn for the second time at least) represented 21% and 27% of berried females in the south and the north, respectively, compared to 17% and 23% in 2008. An egg production index was obtained by multiplying the abundance index of berried females for each 1-mm size class by the size-specific fecundity. In 2011, the egg production index for the Magdalen Islands was 3.4 times higher than that calculated for 1994 to 1996, before the MLS was increased. Also that year, multiparous females contributed to 32% of total egg production.

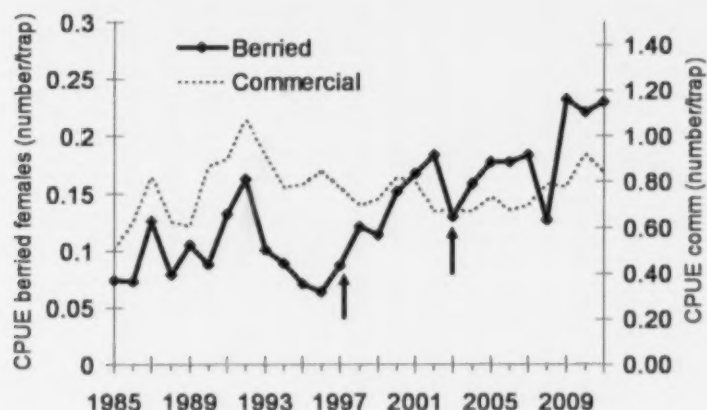


Figure 7. Catch rates (CPUE) of berried females for the Magdalen Islands from 1985 to 2011. The first arrow indicates the start of the increases in MLS and the second arrow indicates the year when the height of the escape vents was increased from 43 mm to 47 mm. The dotted line indicates CPUEs of commercial-size lobsters during the same period.

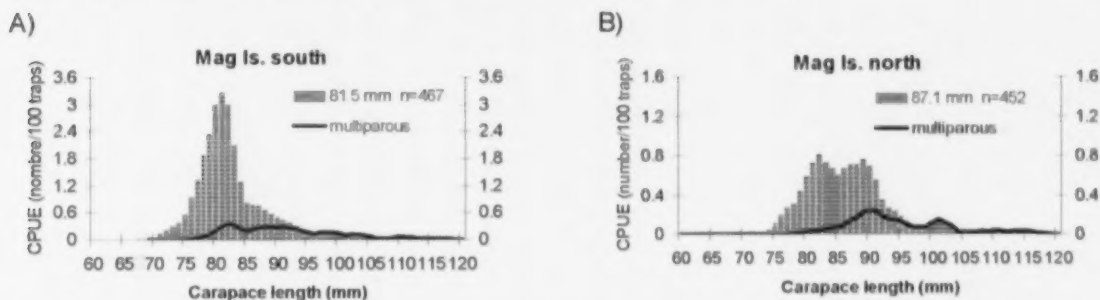


Figure 8. Size distribution frequencies of berried females on A) the south side and B) the north side of the Magdalen Islands in 2011. The black line represents multiparous females. The distributions are weighted by the abundance indices (annual CPUE). The average size and total number of berried females measured are indicated.

Since 2004, at the time of the trawl survey, females ≥ 80 mm and in recent postmoult have been examined to see if they have a sperm plug in the entrance of the seminal receptacle. The presence of a sperm plug indicates that the female has mated and that there is sperm in the seminal receptacle. The purpose of this type of observation is to detect any anomalies in mating

success that could be consistent with too strong fishing pressure on males and with a sex ratio imbalance. In 2011, about 69% of females had a plug compared to 81% in 2008. Percentages were lower over the past three years (67 to 69%). Between 2004 and 2007, rates fluctuated between 70 and 79% without showing a trend. The recent decrease in rates is still no cause for concern, but the situation must be monitored. A partial explanation for these low rates is that sampling could have been done before the end of the reproduction season.

Recruitment

Commercial-size lobster biomass estimated during the trawl survey in a given year gives a fairly good prediction of total landings in the Islands the following year (Figure 9). The biomass index from the 2011 trawl survey (5.4 kg/1 000 m²) was lower than that of the past two years (6.2 and 6.1 kg/1 000 m² in 2009 and 2010, respectively), but it still suggests high landings for 2012 (similar to the past five years, excluding the very high number in 2010). The abundance indices observed in the trawl survey for pre-recruits and juveniles remain high, which suggests that good recruitment to the fishery will be maintained in the medium term.

The benthic settlement on the Les Demoiselles site (Figure 2) has been higher on average since 2002 compared to what was observed between 1996 and 2001. The high values in recent years coincide with the increase in egg production. However, benthic deposition is also influenced by wind strength and direction during the larval period. Benthic deposition observed in 2010 and 2011 was exceptional, with a density of young-of-the-year reaching 5 and 3 lobsters/m², respectively. These values are three to five times higher than that observed in 2008, which was described as excellent all the same. The survival of these young lobsters until they reach commercial size is still uncertain. However, it is possible that the high number of landings in 2010 is related to the strong deposition observed in 2002 (1 lobster/m²). The 2002 cohort was the strongest observed between 1995 and 2007.

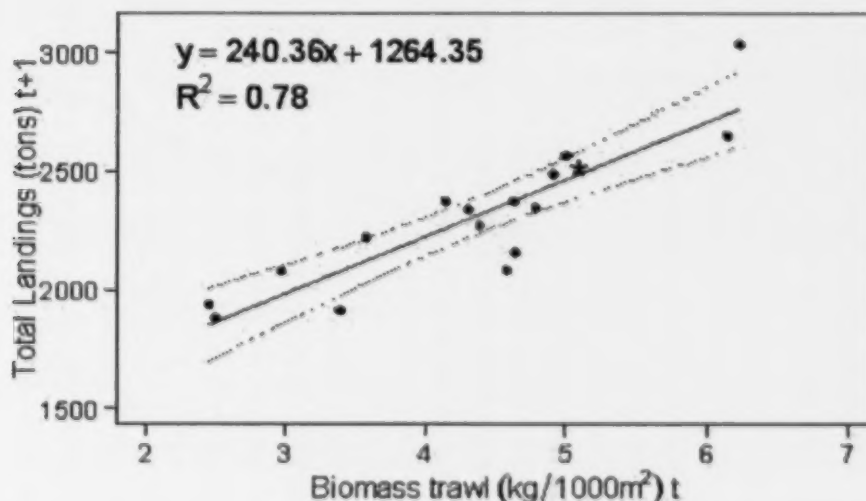


Figure 9. Relationship between the commercial-size lobster biomass index from the trawl survey in a given year (t) and the total lobster landings in the Magdalen Islands one year later ($t+1$). The dotted lines show a confidence interval of 95% around the regression line. The star shows the biomass value observed in 2011 and the prediction for 2012.

Precautionary approach

A precautionary approach (PA) based on an empirical method was suggested for the lobster fishery in the Magdalen Islands. The limit and upper reference points (LRP and URP) and the stock status zones (healthy, cautious and critical) were defined from a stock biomass indicator and in compliance with the DFO operational policy framework (DFO 2009). According to the definition in the framework, a stock is considered to be in the critical zone if its biomass is less than or equal to 40% of the biomass corresponding to the maximum sustainable yield (B_{MSY}). The level of 40% of B_{MSY} corresponds to the LRP. The stock is in the healthy zone if its biomass is higher than 80% of B_{MSY} (the level corresponding to the URP). The stock is in the cautious zone if its biomass is between the LRP and the URP. In the absence of estimates of a stock's biomass from an explicit model, the framework states that provisional estimates of B_{MSY} can be used. Since there are no biomass estimates for lobster stocks in the Magdalen Islands, a provisional estimate of B_{MSY} was taken by using landings from a productive period. In the case of the Islands, landings are considered as an indicator that is reasonably representative of the biomass. Average landings from 1985 to 2009 were used as an approximation of B_{MSY} . These 25 years correspond to a productive period for lobster during which at least two generations of them were produced in large numbers. Average landings from 1985 to 2009 were 2 188 t. The LRP (40% x average) is 875 t and the URP (80% x average) is 1 750 t. The LRP of 875 t corresponds to the landings observed in the early 1970s, which were among the lowest recorded in 60 years. At that time, the stock was considered overexploited. We cannot state with certainty that it is a limit below which stock productivity would be compromised. However, it is a point from which it is presumed that the stock would be likely to rebound as long as environmental conditions remain favourable for lobster. The stock is considered stronger today than it was in 1970 because the spawning biomass is now higher following the increase in the MLS. In 2011, with landings of 2 648 t, the stock is considered in the healthy zone.

Ecosystem considerations

Although lobster traps can be very selective, some non-targeted species that enter them are brought to the surface and returned to the water. A bycatch inventory was taken during the 2011 lobster season. There were 54 fishing trips where all of the bycatch species were identified, counted and weighed. A total of 19 species were listed. Bycatches during the 2011 lobster season were estimated at 93 t, which represents about 3.5% of lobster landings. Rock Crab, Longhorn Sculpin, Green Sea Urchin, Sea Raven, whelk and Ocean Pout made up more than 90% of the catches (in weight). On the whole, bycatches were considered negligible. For most (except maybe Rock Crab, which can be landed), bycatches were returned to the water alive. One American eel and 20 Atlantic cod, two species listed by COSEWIC as of special concern in the first case and endangered in the second case, were observed in the catches.

Sources of uncertainty

Coverage of at-sea sampling is poor (0.14% of fishing trips), which brings about uncertainties in the representativeness of the estimates. Although it is considered that catch rates reflect lobster abundance on the sea floors, they can also be affected by catchability variations that bring about uncertainty in their interpretation. Changes in catchability can also create uncertainty in the calculation of exploitation rate indices. Spatial fishing patterns can affect the abundance index of berried females if, for example, fishers avoid areas where these females can gather. Predictions for recruitment to the fishery from data on benthic deposition are not very accurate because of the variability of age at recruitment and uncertainty as to the survival of lobsters between the time of their benthic settlement and their entry into the fishery 8 to 10 years later. There is also uncertainty as to the representativeness of small-scale observations for the entire population.

CONCLUSION

It can be concluded that with its high abundance and productivity, the lobster stock in the the Magdalen Islands is in good shape and that in the present environmental conditions, current exploitation levels do not compromise its sustainability. However, a decrease in exploitation rates could theoretically improve the size structure.

A precautionary approach was suggested and two reference points (limit and upper) were determined in order to define the three stock status zones (healthy, cautious and critical). Lobster stocks in the Islands are currently in the healthy zone. Decision rules and management for each stock status zone were established with the industry and will guide management decisions as of now.

SOURCES OF INFORMATION

This Science Advisory Report is from the February 1–2, 2012 regional peer review on the Assessment of the lobster in the Quebec's inshore waters. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at: <http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm>.

DFO.2009. A Fishery Decision-Making Framework Incorporating the Precautionary Approach. <http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/fish-ren-peche/sff-cpd/precaution-eng.htm>

Gendron, L. and G. Savard. 2012. Lobster stock status in the coastal waters of Québec (LFAs 15 to 22) in 2011 and determination of reference points for the implementation of a precautionary approach in the Magdalen Islands (LFA 22). DFO Can. Sci. Advis. Sec. Res. Doc. 2012/010.

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